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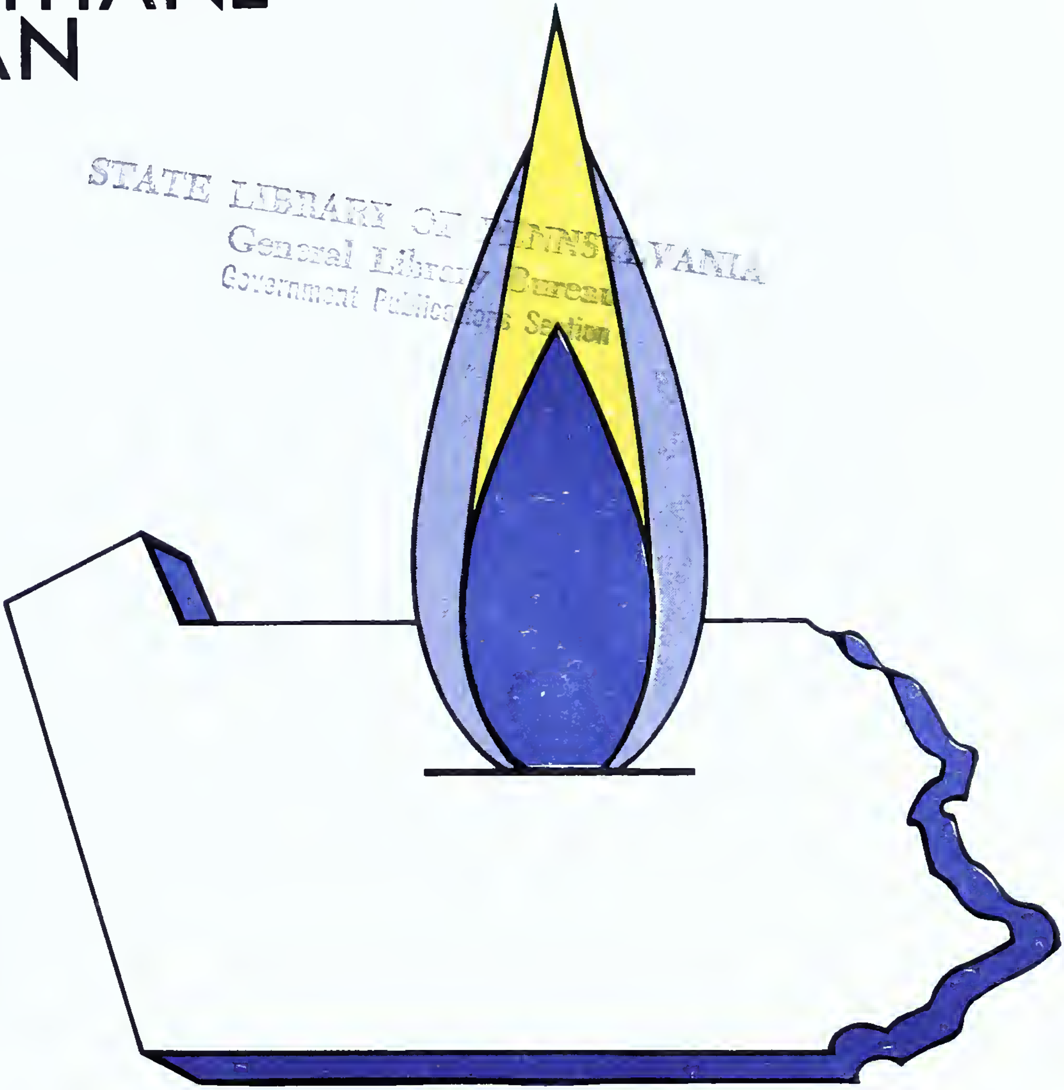

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MILTON J. SHAPP
governor

A Publication of the Office of State Planning and Development
A. EDWARD SIMON - director

PRELIMINARY REPORT

THE PENNSYLVANIA METHANE PLAN

COMMONWEALTH OF PENNSYLVANIA
Milton J. Shapp, Governor

OFFICE OF STATE PLANNING AND DEVELOPMENT
A. Edward Simon, Director

Prepared by
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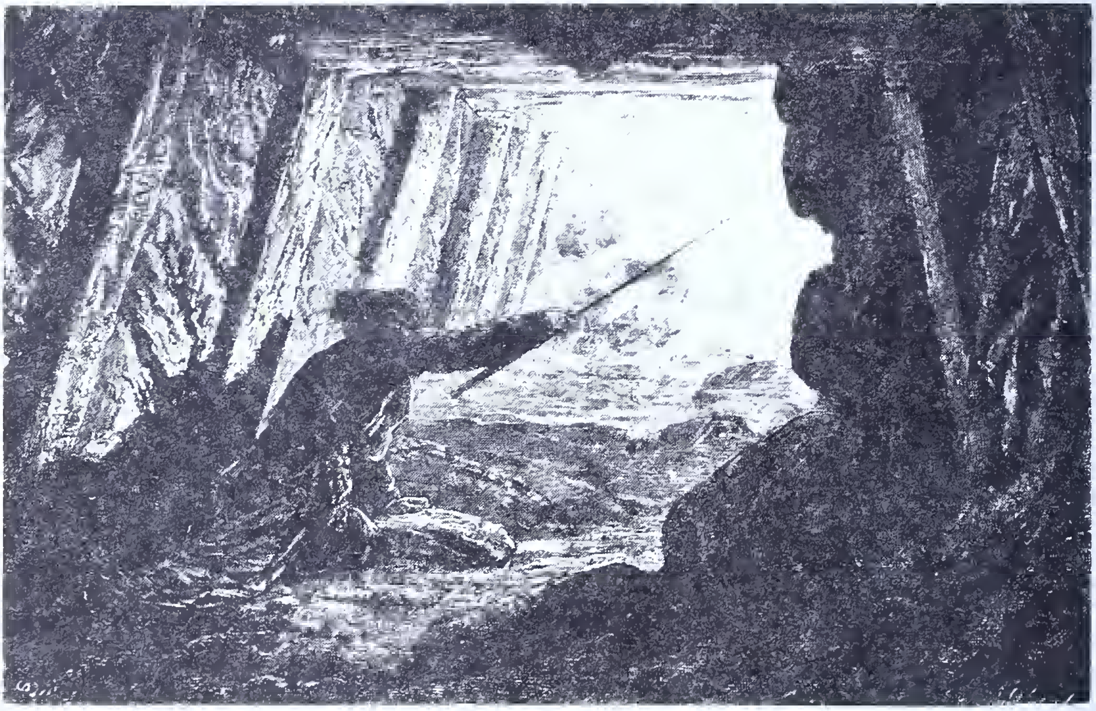
Harrisburg, Pennsylvania: September, 1975



METHANE "CONTROL" IN 1600

The sometimes incredible lengths to which coal miners went in trying to protect themselves against the hazards of methane gas centuries ago have rarely been more graphically demonstrated than in this illustration, reproduced here by the courtesy of the Science Museum, London.

A description of firing appears on page 7.

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THE PENNSYLVANIA METHANE PLAN

The Pennsylvania Methane Plan is a proposal by the Shapp Administration that coal mining companies and other private businesses undertake a voluntary program to augment natural gas supplies immediately and on a long-term basis. It meets a critical need and fulfills a unique opportunity.

It was initially developed in the Governor's Office of State Planning and Development to encourage and assist the State's coal and gas companies in joint ventures, privately funded for private profit, privately conducted for public benefit.

Natural gas, especially since World War II, has been an essential fuel for Pennsylvania. More than 2.1 million homes and more than 150,000 industrial plants and other businesses depend on gas for countless purposes, from heating water to providing the basic chemical ingredient for fertilizer.

The quantity of natural gas consumed in Pennsylvania rose more than 30% from 1963 to 1973. But the sudden decline in the production and reserves of natural gas threatens the availability of supplies at the current level, not only for the present but for the rest of this century.

In 1975, Pennsylvania's industrial gas users face curtailments amounting to 35% of their accustomed supplies, or a total of about 140 billion cubic feet.

While many industrial gas users have, through conservation or conversion to other fuels, reduced their gas requirements somewhat, others are unable to do so. Regardless, faced with dwindling production and reserves, new supplies are essential.

Supplemental Sources

Among the possible sources for supplemental gas supplies and some brief comments on their inherent problems are:

Liquefied natural gas (LNG):

. . . . imported from the Mid-East and South America;
. . . . sources are unreliable, U.S. terminal and storage facilities are inadequate;
. . . . costs are high;
. . . . impact on foreign trade balances is unfavorable.

Gasification of coal:

.... many conversion plants would be needed for Pennsylvania alone;
.... construction costs are high ($350 million and up, each in 1973; higher today);
.... coal supplies are inadequate; costs of gas produced would be high;
.... construction time is too long for short-term or mid-term relief.

New natural gas fields:

.... discovery and development is highly speculative and uncertain;
.... exploration is under-capitalized; benefits will come late and slow.

Substitute gas (propane, etc.):

.... supplies are limited;
.... costs are high.

Synthetic gas:

.... processes to manufacture "natural gas" from methanol, naphtha, etc., suffer from coal gasification's problems, plus scarcity and high cost of raw materials.

Fortunately, an unexpected abundant natural augmentation for natural gas has recently been identified, and its application to current energy problems appreciated. In this, Pennsylvania finds itself in a unique and privileged position.

The augmentation is methane gas. It is found in many natural and geologic locations but -- in reference to this Plan -- it is present in significant volumes in unmined coal, which is an abundant Pennsylvania resource.

Methane can be extracted from the coal before mining. It is widely believed that this will not interfere with mining the coal at some future time. Nor will it affect the quality or character of the coal.

Borings into virgin coalbeds can be connected directly with pipeline systems which deliver natural gas to residential and industrial users throughout the State. Little or no processing is required. Equipment and materials are well within present limits. Technology is at hand and generally accepted.

Pennsylvania's Great Potential

About 150 companies operate deep mines in the gassy bituminous coal fields in Pennsylvania, where there are proven reserves of up to 61 billion tons – coal which won't be mined for years to come.

It is estimated that these reserves, alone, hold 11.8 trillion cubic feet of methane gas, or about 75 times the anticipated curtailment of 140 billion cubic feet of natural gas for all utilities in the State this year.

It is also estimated that, with an investment of some $200 million, an annual flow of at least 150 billion cubic feet of methane can be extracted from these coal lands and piped to the gas-hungry utilities throughout the Commonwealth.

Such a project could be completed in 3 or 4 years; as a crash program, it might even be compressed into a few months. The invested capital could be recaptured in 1½ to 3 years of operation by the sale of the methane to the gas utilities at rates no greater than they pay for interstate pipelines gas.

The coal companies would then have a new, substantial and investment-free income for years to come. Their operating and maintenance costs are expected to be low. The coal companies would also enjoy the additional operational savings resulting from having rid themselves of billions of cubic feet of methane in advance of mining.

> (Dr. Robert Stefanko, Assistant Dean of the College of Earth and Mineral Sciences, Pennsylvania State University, estimates the cost of ventilating mines at $.50 per ton of coal; hence, mine owners and operators could reduce ventilating costs by as much as $2.5 million per billion cubic feet of methane extracted before mining.
>
> (If the minimum objective of 150 billion cubic feet of methane per year is reached coal mine operational savings could be significantly high.
>
> (Even more substantial savings are expected to result from the reduced frequency and duration of mine shut-downs because of high methane levels.)

The gas utilities would have a badly needed, dependable, enduring and low-cost new source of gas.

METHANE -- WHAT IS IT?

Methane is a colorless, odorless, tasteless combustible gas, about 40% lighter than air under normal atmospheric pressures and temperatures.

Chemically, it is CH_4, the product of the union of one atom of carbon and four atoms of hydrogen. In the presence of oxygen and a spark, it combines to produce water (H_2O), carbon monoxide (CO), carbonic gas (CO_2) – and heat.

Heat is measured in British thermal units (Btu's), and the heat produced by one cubic foot of methane is the same as that produced by one cubic foot of natural gas – approximately 1,000 Btu's.

One hundred cubic feet of methane will bring a 42-gallon barrel of ice water to the boiling point. It is the heat equivalent of 8 pounds of coal. It is the energy equivalent of 3 quarts of gasoline. It is the cost equivalent of $.05 worth of natural gas at 1974 wellhead prices.

It burns with ecological purity. Its discharges into the atmosphere after combustion will not harm living creatures or damage inert substances.

In addition to its superlative qualities as a source of energy, methane is also a basic substance in the manufacture of ammonia. Ammonia, in turn, is an essential ingredient in manufacturing farm fertilizers, and explosives which are needed to mine that other great source of energy, coal.

Origins of Methane

Since the beginning of time, Earth has been a huge apparatus for making methane.

It has bubbled up from decaying vegetation in swamps for hundreds of millions of years. In fact, among its many common names, it has long been called Marsh Gas or Swamp Gas, and it still escapes from swamps and wetlands and mixes harmlessly with the atmosphere.

While the Earth was being wracked by enormous upheavals, large swampy areas were swallowed up in countless places and buried deep to form embryo coalbeds. Methane has remained locked in the coal formations to this day. It is now released when men burrow down into the coalbeds and expose them to the atmosphere. Methane then escapes and creates hazardous conditions for miners, unless it is drawn away by ventilation systems.

The same upheavals also created deep pockets of decaying swamp. These pockets, when found and tapped by man, have produced so-called natural gas, but it is still primarily methane.

Whatever it is called – marsh gas, coal gas, natural gas or methane – it is a resource we have undervalued, abused and wasted for too long.

Slow Awakening

The question always occurs: If methane is so valuable, and if the technique of recovering it from coalbeds is so simple a concept, why wasn't it recovered and used long ago?

There are two reasons for this slow awakening: economics and the law.

The cost of deep mine ventilation, however, great, has always been a minor factor among all coal mining expenses. Consequently, there has usually been little thought given to methane-related economies.

Furthermore, natural gas was plentiful and cheap, and its market until the late 1940's was relatively small. There was a little need for a supplemental supply at any cost, in any volume.

Coal mines had more pressing needs for capital. Methane extraction was not attractive to an industry whose financial problems multiplied every year.

In Pennsylvania, if not elsewhere, there was always a question as to the ownership of the methane in the coal. No one questioned the right of coal mine operators to pump methane out of the mines for safety purposes. But to extract and market it for profit as a supplement to natural gas supplies was another matter.

The status of the law in Pennsylvania, as interpreted by the Attorney General, is that economic control of methane belongs to the owners or leasees of gas rights. And since much, if not most, of the coal lands throughout the State have been sold or leased for gas well explorations and drilling the legal complications are obvious.

Coal company executives today, impressed by expectations of new rises in value of natural gas, are taking a new look at the possible advantages of extracting methane ahead of active mine operations. But they are still understandably reluctant to convert their formerly unwanted methane to public energy needs if this will lead to long and costly legal actions.

Pennsylvania's coal mines today are still venting millions of cubic feet of methane into the atmosphere every day, while the energy crisis worsens.

A HISTORY OF METHANE REMOVAL

Accounts of the use of coal date back almost 400 years before Christ. Aristotle and Theophrastus wrote of rock that burned. Remains of early Roman fortifications in Britain have disclosed coal heaps.

Initially, methane was no problem. Early mines in Greece and what is now Belgium were simply pits, following veins down from outcroppings on the surface. Methane had little chance to accumulate and was little noticed.

Pits gave way to shafts which were enlarged at their base when they encountered coal veins. Probably miners were not seriously affected by methane emanations until the technique of tunneling was developed. This was well before 1100 A.D., when coal production in northern Europe was considered "extensive."

In 1210, five years before the signing of the Magna Carta, coal was important enough in England to have warranted an official charter to permit the monks at Newbottle Abbey to conduct mining operations.

By the late 13th Century, Parliament was being pressed by owners of forest lands to restrict the growing coal industry. In 1273, they enacted a smoke abatement law. A second and more stringent one, in 1307, totally banned burning coal in furnaces; at least one man was actually executed in 1308 for violating it.

Early Evidence of Methane Dangers

Attention was also called in this same period to the hazard that methane posed to the men, women and children who went into the blackness and foul air of deep mines to dig out baskets of coal. If it asphyxiated them, they called it choke damp. If it flared into flame, or exploded from their candles, they called it fire damp.

Either way, it was deadly. As early as 1322, there is record of the death from choke damp of "Emma, daughter of William Culhane," as she worked in an English mine.

Efforts to get the gas out of mines started with the idea of digging ventilating shafts so that surface air could sweep through the tunnels from one shaft to another; these may have provided some relief, but not much. To stimulate the flow of air, miners would fan the air with large sheets of cloth to make it move along; this could not have been much more effective.

Coal production in England was some 200,000 tons in 1550, and

John Caius, founder of Gonville and Caius College at Cambridge, wrote of methane as "the unwholesome vapour. . . . so pernicious to the hired labourers, that it would immediately destroy them."

Firing -- A Perilous Procedure

In the 1600's, the practice of "firing" seems to have been the next methane-control technique. This required one of the mine crew to wrap himself in wet cloth, and creep through the mine "on his belly with a large pole before him, with a lighted candle on the end thereof." When the candle reached an accumulation of gas, it "breaketh with violence, and running along the roof goeth out with a noise at the mouth of the Sink."

And what about the "fireman?" According to an early account, he "escaped by creeping on the ground, and keeping his face close to it, till it be overpassed which is in a moment."

Although, strangely enough, it had been suggested by miners, themselves, after the candle carried by one of them touched off a blast that temporarily cleared their working area of gas, it is understandable that removal of methane by firing had only limited appeal. Nevertheless, firing was still being practiced as late as 1808.

Meanwhile, a more desirable way evolved. Lighted braziers were placed at the ventilating shafts, creating updrafts which stimulated the flow of air.

Nevertheless, British coal mines were now often as deep as 350 feet and mine explosions were increasingly frequent and tragic. Thirty men, women and children were killed in Gateshead mine, October, 1705. On the morning of August 18, 1708, 69 miners who were already (or still) in the pits at 3 a.m., were killed by a gas explosion set off by a candle carried by a worker on the surface.

Eighteenth Century Methane Drainage

Methane drainage in a real sense, probably started when a young engineer, Carlyle Spedding, about 1735, was putting down a shaft for a new mine, and encountered a great flow of firedamp from one point as he came into the coalbed. He walled off the gassy area with "a tight framing of timber. . . .to dam back the gas out of the pit: a small pipe two inches square being led to the surface from behind the framing which carried off the gas to the open air." Then he proceeded to mine the vein in an opposite direction, without undue methane dangers. His ingenuity paid off, and Spedding and his son, James, continued to drain firedamp from mines they designed.

By 1800, other new ideas were being tried. A physician, having witnessed a mass funeral for 32 miners killed in a blast, proposed fumigating mines with chemicals which would neutralize firedamp. New arrangements in planning mines to permit better air flow, were introduced. Open braziers at the mouths of ventilating shafts which sometimes caused explosions, began to be replaced with steam jets.

In 1813, the scientific community at last took notice of the coal mine owners' inability to control firedamp. The open flame of miners' candles was recognized as a hazard which had to be eliminated. Obviously, miners couldn't work in the dark and needed a light source which would not touch off the uncontrolled flow of firedamp. Dr. W. Reid Clanny presented a paper on a safety lamp before the Royal Society in London in 1813. Sir Humphrey Davy, Britain's leading scientist, was asked to "consider the problem."

However, two years and many disasters passed before Davy started his work in August, 1815. Once started, he produced three types of safety lamps in only two months, and they had their first successful tests in January, 1816.

The problem of bringing light into coal mines had been solved, but the question of what to do with the methane had been bypassed.

In 1844, following a mine blast which killed 95 men, new ventilating procedures and standards were adopted and made law in Britain, but they eliminated neither the cause of mine explosions nor the explosions themselves.

Pennsylvania Developments

Meanwhile, across the ocean in William Penn's lands, a man named Gabriel Thomas reported that he had found deposits of coal in 1698, but he seems to have caused little excitement. It was 70 years later before mining was started in earnest by a group of colonists who had formed the Susquehanna Company and had bought 484 square miles of the Lackawanna and Wyoming Valleys from the Ten Indian Nations. Their coal was just in time to provide fuel for forges where much of the weapons for the revolutionary forces was manufactured.

About the same time, the Proprietors of Pennsylvania bought up coal lands near Fort Pitt, and leased them out for development.

As late as 1820, the total American output of coal was only 1,300 tons a year, mainly by quarrying. (The term "strip mining" had not yet been coined.) As deep mining came into practice, American coal miners shared the same hazards and the same working conditions as their brothers in other parts of the world.

Methane was the great killer of coal miners throughout the 19th century in America as well as Europe. In Pennsylvania, alone, in the last half of the 19th century, records of mine accidents in which 5 or more miners died list 43 methane explosions or fires in which 747 men were killed. If the toll of methane explosions in which fewer than 5 miners were killed could be added, the recorded figure would possibly double.

The frequency and death tolls of methane explosions and fires increased repidly through the early years of the 1900's, until enforceable mine safety laws brought about strict observance of low methane levels in mines.

After Safety Came Profits

Then the emphasis in methane studies took a slightly different tack: What could be done to add to the safety of miners? Secondarily, what could be done to reduce the frequency and duration of costly "down time" in mines where methane levels, despite all engineering and ventilating efforts, would become too high for human safety?

Many references to drilling methane vent holes into coalbeds ahead of actual mining can be found in textbooks, talks and studies dating back almost 50 years. Few mining engineers had not noticed that, when core samples were being taken to determine the location and thickness of underlying coalbeds, methane frequently followed the core to the surface and kept on flowing. Surely, many must have thought of drilling large numbers of holes to vent much if not all of the gas before mining through. This would have increased the safety factor and reduced down time costs – both desirable objectives.

But there were some who saw more than safety and operational economics in methane drainage – those who realized its value as a fuel, itself, independent of the value of the coal in which it was imprisoned. Two of these men, Lawall and Morris, told the American Institute of Mining Engineers in 1934:

"Data were gathered on six (West Virginia) mines that liberate approximately 23 million cubic feet of inflammable gas every 24 hours during normal production of coal. The probable value of so much gas . . . .would be $2,300 per day." (Emphasis added.)

At least one gas utility company is reported to have conducted an extraction and marketing program on a modest scale for more than 25 years.

Deans Robert Stefanko of Penn State and J. Hilary Kelley of West Virginia University, among others, have a 20-year record of advocating methane removal and utilization.

But these early proponents of methane drainage and recovery were unheard in most listening posts throughout the gas and coal industries, throughout government and political circles, throughout academia itself. The long trail, from Aristotle's "burning stones," through two thousand years of man's struggles against death and destruction in the dark, finally came to a resolution through a marriage of technology, economics and government action in the third quarter of the 20th century.

THE TECHNOLOGY OF METHANE REMOVAL

For the purpose of this discussion of the Pennsylvania Methane Plan, it is best to concentrate on the removal and use of methane as an unadulterated gas – that is, methane as it exists in a captive state within unmined coalbeds without an admixture of air.

There have been efforts to use the mixtures of methane, air, water vapor and other gases as they are vented from mines in compliance with safety practices and regulations. However, the capital investment for a treatment plant which would extract pipeline quality methane from these mixtures was in the range of $350 million to $500 million in 1974. For this much money, other energy-producing efforts may be more attractive to both the investor and the public.

This is not to say that mixtures of methane and air are without uses. There have been numerous reports of coal mines which have burned part of their gob gas bleed-off to support their own operation – boiler heat for small mine engines, heat for drying coal, etc. Industrial efforts to use methane gathered by hoods over gassy swamplands have been reported. Homes near abandoned and sealed mines are often said to be heated by methane drained from gob piles. Sewage treatment plants can often supply all the energy they need for their operations by using the methane given off by their processes. Even farmers find they can use methane produced by manure to run small generators and equipment, and to heat barns.

Extraction Techniques

The billions of cubic feet of pipeline natural gas which are required for residential, commercial and industrial use throughout the country every day are, generally, pure CH_4 with only slight admixtures of CO_x, and with an average rating of 1,000 Btu's per cubic foot. Almost all of it comes from deep natural gas wells.

"Natural gas can be produced from coalbeds by drilling holes from the surface into the coalbed." Maurice Deul made this statement before an American Gas Association meeting at Bal Harbor, Florida. in May, 1975. Deul is Research Supervisor for Methane Control and Ventilation, U.S. Bureau of Mines, and a pioneer as well as an acknowledged leader in this field.

He summed up the techniques known to be useful: vertical boreholes. and directional slant boreholes.

Vertical Drilling

Vertical boreholes, as the words imply, start on the surface above the coalbed, and are drilled directly down into the coal. They are cased, and generally about 6 inches in diameter. The bottom casings, in the coalbeds, are perforated to permit the gas to flow from the coal into the borehole. Under the natural pressure of the overburden (about 0.7 psi per foot), the methane seeps through its natural migratory passages in the coalbed into the cased borehole, and up to the surface. Pressures at the surface are generally not sufficient to move the gas laterally into and through a gathering system, and pumping will be required.

This is the least costly, in terms of capital investment, of the presently known techniques of methane drainage. It is also the least demanding in terms of time.

Horizontal Drilling

Horizontal boreholes were dramatically demonstrated by BuMines at the Eastern Associated Coal Company's Federal Mine in West Virginia. They sank a 4-foot shaft to the coalbed, some 830 feet below the surface. As they neared the roof of the coal, they tapered out so that they had a working chamber of 14 feet in diameter in the 8-foot thick bed. From this chamber, they drilled 3-inch borings horizontally in several directions and to varying lengths. Deul reports the total length of the borings was 4,325 feet, and "the rate of gas emission per day from each linear foot of hole for 951 days averaged 131 cubic feet."

He also reports that another test in the Pittsburgh coalbed involved five holes totaling 5,830 feet; in 608 days, it produced 540 million cubic feet of methane, or 152 cubic feet per day per foot of hole. A third example, in the Beckley coalbed, yielded 250 cf per linear foot per day in a short, 200 foot hole, until it had to be plugged to allow it to be mined through.

Current estimates on reproducing the Federal Mine demonstration exceed $1 million in capital costs, and three years in development.

Directional Slant Drilling

Although the yields in horizontal drilling indicate an expectancy of 100 to 300 cf per day per linear foot – a gratifying result, both from the standpoint of mine safety and energy production – the cost and time consumed in sinking a working shaft far ahead of current mine operations can dampen some of the enthusiasm for horizontal drilling.

But Deul also reports on new tests "to demonstrate the feasibility of drilling holes horizontally into the coalbed starting from the surface." (Emphasis added.) This technique calls for special drilling abilities in which the direction of the hole is "flattened out" in stages so that, by the time the drill enters the coalbed, it is in a horizontal attitude.

Deul cites a test in the Pittsburgh coalbed where 400 feet of a 3-inch hole was drilled horizontally into the coal, starting from the surface 760 feet about the roof of the bed. He concludes: "The experiment did show that productive horizontal drilling in coalbeds can be achieved without opening a mine to the coalbed."

There are not enough useful data on costs or time involved in slant-hole drilling at this time.

Multi-bed Drilling

Another possibility which many experts feel holds great promise, but which is yet to be tested, reverts to the vertical drilling technique. Since coalbeds exist in layers of varying depths and thicknesses, it is feasible for a single vertical boring to penetrate and drain more than one coalbed.

Several questions must be answered in assessing the value of such multi-bed operations: Should borings into two or more beds drain them simultaneously, or one at a time? If one at a time, in what order? Will methane from one bed migrate through the boring into another bed, rather than surfacing? Will borings into deeper (or thinner) beds interfere with mining through paper (or thicker) beds?

Hydraulic Stimulation

Veteran geologists and mining engineers have long known about hydraulic stimulation under the name of "fracturing." Like most changes, this new terminology comes slowly. Yet the new term is more appropriate than the old, because it describes the result of a process which can take many forms, rather than a single technique. Also, to the men who go deep into the earth to mine coal, there has always been something disturbing in the word, fracture; it raises images of roof falls and mine disasters.

Hydraulic stimulation is a process by which liquids, usually bearing gelatins and fine sands, are forced under steady pressures into coalbeds. Tiny microscopic avenues for the escape and drainage of the methane in the coal are opened over a wide area. As the liquids are drained out, gas is freed, and its flow is accelerated.

For example, Deul cites three test boreholes in Pennsylvania which yielded a total of 12.0 Mcf of methane per day before stimulation, but

60.5 Mcf per day after stimulation. A fourth, which produced nothing before stimulation, yielded 15.9 Mcf per day afterward. A hole in Alabama increased from 4.9 to 45.5 Mcf/d. Three in West Virginia rose from 7.2 to 50.2 Mcf/d.

There is little doubt that the principle of hydraulic stimulation is an important element in planning and executing methane drainage programs. When properly done, it is believed that the integrity of the coalbed is unaffected. There has been no evidence in any of the many drainage holes that have been drilled and stimulated, whether for experimental or operational purposes, of any structural defects having resulted in the coal.

Nevertheless, it is also true that the experience has been limited, and the records of findings may be open to question. Certainly, more study was started by the Pennsylvania Science and Engineering Foundation, a State government funded and operated program, when it put seed money into a project proposed by Stefanko early in 1975. One of the objectives of this study, in which the U.S. Bureau of Mines is also participating, will be to determine what effect hydraulic stimulation may have on coalbeds when they are subsequently mined through.

Ultra-deep Potentials

Some coalbeds exist at depths far greater than can be safely or profitably mined, using present technology and equipment. However, it is believed that these deposits are at least as gassy as their overlying beds; perhaps, as some experts surmise, substantially more gassy.

As we face decades of energy shortages, the possibility of making short-term use of the methane locked in these deep coals becomes attractive. Through vertical drilling from the surface, coal veins which we may not be able to mine for a century or more may yet be able to yield low cost methane in substantial quantities.

High, Thin Coalbeds

The final unexplored potential in this program focuses on coalbeds which are too thin to be deep-mined economically. If they lie close enough to the surface, they may be strip-mined at a profit. But below certain levels, mining is economically feasible only if the coal is at least four or five feet thick.

On the other hand, methane exists to varying degrees in most coalbeds, thick or thin. The prospects of methane extraction from coalbeds too thin to be profitably mined with known and available techniques are believed to be good enough to warrant exploration.

Not only is the technology of methane extraction sufficiently advanced today to support a large scale program in bituminous areas, but the possibility of taking advantage of ultra-deep or thin coalbeds offers exciting additional prospects.

Equipment and materials, as well as engineering and operational personnel, are available now for almost any kind and scale of methane recovery programs at acceptable costs.

PROBLEMS OF THE METHANE PLAN

There is a baffling assortment of legal and economic problems which must be resolved suitably before the Pennsylvania Methane Plan can be put into operation. Foremost is the question: Who owns the gas?

Logic would dictate that, as long as the methane is literally in and of the coalbed, it belongs to the property owners or those who have leased rights to mine and sell the coal. But, as stated earlier, this is not always necessarily so.

If someone else has leased the natural gas rights on that same property, he has economic control of the methane, according to the Attorney General of Pennsylvania. He is the only one who may legally sell it, even though it must first be extracted from a coalbed which he doesn't own or lease.

The coalbed owner or lessee has no right to sell it in the presence of an adversely held gas lease. He may, can and, in fact, does extract methane from his coalbed for safety reasons, but he can't sell it. There is even some question as to whether he can legally use it for his own benefit; i.e., to run his own mine equipment. All he can do with the gas, without risking a lawsuit, is to vent it into the atmosphere.

> (It is interesting to note that C. C. Williams, Jr. wrote extensively on this subject in the West Virginia *Law Quarterly*, while he was on the faculty of the Law School of West Virginia University, in 1941. He was not able, one-third of a century ago, to bring about a clear resolution of the legal problems, which might then have brought about a program of methane recovery and utilization. The answer is still clouded.)

Basic Rights Deadlocked

Assuming that a gas lease holder wanted to exercise his right to extract and sell the methane from a coalbed owned by someone else, how would he do it? He would have to drill into coal which he does not own. Further, he would affect the physical properties (no matter how slightly) of another man's coal for hundreds, perhaps thousands of feet surrounding his boring when he hydraulically stimulates the coalbed. Is the man who has rights to the coal going to stand by idly, and let his holdings be invaded and possibly adversely affected? Very unlikely!

So there is a deadlock, a polarization. It can be resolved by agreement of the adverse parties -- coal companies and gas producers -- or by the enactment of new laws.

Efforts by the state government to bring the two sides together were started as early as the Fall of 1974. By the following summer, the parties themselves had not completely agreed on ways to implement a program.

It is hoped and expected that voluntary agreements between coal and gas industry leaders will make new legislation unnecessary.

Pricing Questions

In an economy where a ton of steel or a pair of shoes sells for about the same price in Oklahoma as in Pennsylvania, it is often difficult to understand or explain the variations of the price of a cubic foot of natural gas. These variations add to the problems of establishing a methane removal program.

There are two gas pricing systems. One, established by the Federal Power Commission, regulates interstate gas – that is, gas which is transported from the wellhead to its point of use in a pipeline which serves more than one state, even though it may be taken out of the pipeline and used before it reaches the state line. The other is an unregulated market in which intrastate gas is produced and consumed in the same state, and transported in pipelines which do not cross state boundaries.

There are no caloric or chemical differences between interstate and intrastate gas. However, in June, 1975, the wellhead prices for gas in Pennsylvania were:

Interstate	$ .51 per Mcf
Intrastate	1.70 per Mcf

There are few large intrastate pipelines in Pennsylvania – none connecting the gassy bituminous coal regions of the southwest corner of the State with the gas hungry eastern and central parts. Therefore, under prevailing conditions, most of the methane recovered from Pennsylvania coalbeds will reach the market at the low regulated interstate price. This, of course, inhibits the enthusiasm that many coal and gas producers have for extracting and marketing methane.

But industry and government officials who recognize the importance of adding to the energy supplies of the State and the nation are seeking prompt solutions to these and other problems which will be in the common interest.

METHANE REMOVAL – PROSPECTS IN PENNSYLVANIA

Since the Pennsylvania Methane Plan was first presented, in December, 1974, great efforts have been made by industry as well as government leaders to resolve the many problems and bring this available source of new energy to public use.

The stakes are high. Curtailments of 140 billion cubic feet of gas were scheduled for Pennsylvania in 1975. All was due to be withheld from the State's industries. The Director of the Office of State Planning and Development, A. Edward Simon, and others have forecast that industries in the State might suffer production losses as high as $2.4 billion in 1975 if replacements were not found.

As many as 143,000 jobs would be in jeopardy.

The gas utilities themselves, faced a possible $125 million decline in revenues because of the cut in the amount of gas they would have available to sell in 1975.

As noted previously, a program calling for an investment of only $200 million could, in short time, add enough coalbed methane to Pennsylvania's gas supplies to make up for this difference, to maintain industrial production, and to substantially prevent any loss of employment due to gas shortages. To encourage private industry to undertake this program, the Commonwealth has acted in many ways:

> The program has been endorsed by the Governor's Energy Council and the Governor's Science Advisory Committee.
>
> The College of Earth and Mineral Sciences at Pennsylvania State University has conducted tests on answered technoligical problems related to methane removal.
>
> The Pennsylvania Science and Engineering Foundation has invested $100,000 to fund Penn State's tests. (The U.S. Bureau of Mines has matched Pennsylvania, and additional contributions to the project have also come from a large coal mine operator and two gas utility companies.)
>
> The Bureau of Topographic and Geologic Survey has checked our coal reserves, and reported that Pennsylvania has up to 61 billion tons of recoverable bituminous coal, approximately half of which may be high in methane content.
>
> Dr. Stefanko, who heads the Penn State methane projects, estimates the possibility of methane recovery from coal in two counties alone – Greene and Washington -- at 520 billion cubic feet. Also, the U.S. Bureau of Mines has stated that the gassiest mines in

Greene and Washington Counties are presently venting 23.3 million feet of methane per day. The 40 most gassy mines in the state pump 43.6 million cubic feet of methane out of their operations and into the atmosphere each day.

Leaders in the coal and gas production industries have met several times with State officials to explore avenues which might lead to resolution of their common differences in favor of a common program. One great advantage to coal mine operators will be the removal of much of the methane gas from their coal before they mine it, reducing their future ventilating costs but – more importantly -- reducing production costs by cutting down on work stoppages which result from dangerously high levels of methane in the mine atmosphere.

METHANE REMOVAL – PROSPECTS IN APPALACHIA

As a member state in the Appalachian Regional Commission an organization of the governors of 13 states from New York to Alabama, Pennsylvania has urged a regional study of the impact of methane removal on the entire nation.

West Virginia, Ohio, Virginia, Kentucky and Alabama stand with Pennsylvania as the national leaders in both reserves and production of bituminous coal. The combined known reserves of gassy bituminous coal in these Appalachian states is many times those of Pennsylvania's. Their total potential calls for the immediate, concerted study and action of all these states. In this, Pennsylvania stands ready, as always, to lead.

Steps have already been taken.

Pennsylvania's representatives on ARC have made our Methane Plan known, in full detail, to their colleagues from the other member states.

Other states have expressed great interest, not only in the Plan but also in Pennsylvania's steps to implement it by coping with its inherent problems.

A recent study by the U.S. Bureau of Mines of the 199 coal mines in the nation which vent more than 100 Mcf of methane per day locates 165 of them in the six Appalachian States noted above. These 165 expel almost 200 million cubic feet of pipeline quality methane gas into the atmosphere daily, or about 73 billion cubic feet per year.

If they had had a plan to utilize it, this wasted gas, even at low regulated values, would have been worth more than $36 million per year to the owners of those mines.

This wasted gas would have had a resale value of at least $50 million per year to gas utility companies.

This wasted gas would have powered more than $1,000 million per year in industrial productivity, and provided perhaps as many as 70,000 permanent, full-time jobs.

This wasted gas would have helped the under utilized gas pipelines with added revenues, would have created new taxes for local and state governments, and would have helped time America over to the day when it can, through other, more permanent energy arrangements, be truly independent again.

The use of this wasted gas would have demonstrated, once again, the great ability of American private enterprise to act in its own best interest.

And it would have furthered the real strength and highest purpose of government – its ability to cooperate, and even to lead, in constructive harmony with the private sector.

This is the Pennsylvania Methane Plan.

It deserves understanding.

It welcomes support.

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This booklet has its roots in the decades of research, study, demonstration and determination of two men without whom there might never have been a Methane Plan in Pennsylvania or anywhere else: Maurice Deul, Research Supervisor, U.S. Bureau of Mines and Dr. Robert Stefanko, Assistant Dean, College of Earth and Mineral Sciences, Pennsylvania State University.

Their ideas came to the attention of Robert Sidman, Coordinator of the Governor's Office of State Planning and Development, who had previously also served as Executive Director of the Governor's Task Force on Energy, who is also responsible for the authorship of the Plan and for the writing and editing of this booklet.

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